Sourcing obsidian from prehistoric sites in northwest Romania

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SOURCING OBSIDIAN FROM PREHISTORIC SITES IN NORTHWEST ROMANIA

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Keywords*: pXRF, obsidian sourcing, Neolithic, Copper Age, northwest Romania*
Abstract: *Portable X-ray Fluorescence Spectroscopy (pXRF) was used to reveal the chemical signatures of 75 obsidian artefacts from seven sites in the Satu Mare region, ranging in age from Early Neolithic (late Starčevo-Criș culture) to Late Copper Age. The results reveal the origin of the obsidian to be the Carpathian 1 source area in eastern Slovakia, reinforcing the pattern documented elsewhere in Romania and in northern Bulgaria which indicates a clear preference for Carpathian 1 obsidian throughout the period from the later stages of the Early Neolithic to the Bronze Age.*

Cuvinte-cheie*: pXRF, surse de obsidian, neolitic, epoca cuprului, nord-vestul României*
Rezumat: *Pentru determinarea amprentei chimice a 75 de piese arheologice de obsidian provenind din nord-vestul României a fost utilizată metoda pXRF. Siturile de proveniență aparțin perioadei neolitic timpuriu – epoca târzie a cuprului. Rezultatele indică prezența obsidianului din sursa carpatică C1 localizată în estul Slovaciei. Acestea sunt în concordanță cu analize anterioare realizate pe probe din România și Bulgaria, indicând astfel în mod clar o preferință a comunităților preistorice de utilizare a sursei carpatice C1 începând cu etapele mai târzii ale neoliticului timpuriu și până în epoca bronzului.*

INTRODUCTION

Obsidian sourcing (matching obsidian artefacts to specific geological sources of obsidian based on their elemental composition) has been used in Romanian archaeology since the 1970s (Williams-Thorpe 1978). However, most previous geochemical characterization studies have been limited to just a few artefacts per site and to relatively few sites. In this paper we report on the geochemical characterization of a large series of obsidian artefacts from seven sites in the Satu Mare region of northwest Romania belonging to the Neolithic and Copper Age periods. This research forms part of a much broader study of obsidian distribution patterns in Romanian prehistory being undertaken by two of us (AB and CB) with the aim of establishing the patterns of movement, modes of acquisition and use of obsidian during different archaeological periods.

SITES AND SAMPLES

The locations of the sites are shown in Fig. 1. Accounts of the excavations and principal archaeological finds can be found in Virag 2008, Astaloș *et alii* 2013, Virag 2014, Chmielewski, Astalos 2015 and Virag 2015. The list of sites, number of measured samples and their cultural attributions are summarized in Table 1.

Călinești-Oaș – *Dâmbul Sfintei Marii (DSM)* is located ca. 0.5 km northwest of Călinești-Oaș, on the slope of *Dâmbul Sfintei Marii* (*Holy Mary's Hill*). Discovered in 1999, archaeological investigation by test pits took place in the same year. The investigations continued on a larger scale in 2000 and 2001 (Németi, Astaloș 2001; Németi *et alii* 2002). Based on the results of the field observations in 1999–2001 (the distribution of the surface finds) and a field survey in the winter of 2008 (Chmielewski, Astaloș 2015) the size of the site was estimated to be ca. 50 × 50 metres.

The stratigraphic integrity of the site was heavily affected by soil erosion and agricultural activities. Two layers were distinguished (Chmielewski, Astaloș 2015):

1. Topsoil (20–30 cm thick) containing lithics (chipped and polished) and small corroded pottery sherds.
2. Yellow clay (with ferro-manganese concretions in places) in which archaeological features could be recognized.

Three pit-features were identified, Cx.1/2000, Cx.1/2001 and Cx.2/2001. To date, only the materials from Cx.1/Sul/2000 have been studied (Chmielewski, Astaloș 2015, fig. 5). The infill soil of this feature contained pottery sherds and an abundant chipped stone assemblage comprising mainly débitage and rare retouched blades. Cx.1/2000 was thus considered to be a 'workshop' for chipped lithic artefacts (Chmielewski, Astaloș 2015). The feature yielded 1457 chipped stone

artefacts. The main raw materials observed were limnosilicite/limnoquartzite (84.8%), vitreous dacite (4.9%), silicified sandstone (4.2%), obsidian (4.5%), Balkan flint (0.3%) and other (1.3%). The 65 obsidian pieces comprised cores (7), blades (18), flakes (34) and debitage waste (6) (Chmielewski, Astaloș 2015, p. 50, table 1).

One obsidian piece probably from feature Cx.1/2000 was subjected to EDXRF analysis by Glascock *et alii* (2017, p. 177), the geochemical composition pointing to a source in the "Cejkov-Viničky area" (Carpathian 1). The six obsidian items from Călinești-Oaș – *DSM* analyzed in our study came from feature Cx.1/SuI/2000, and comprise two platform cores, three split pebbles and one unworked fragment (Table 2).

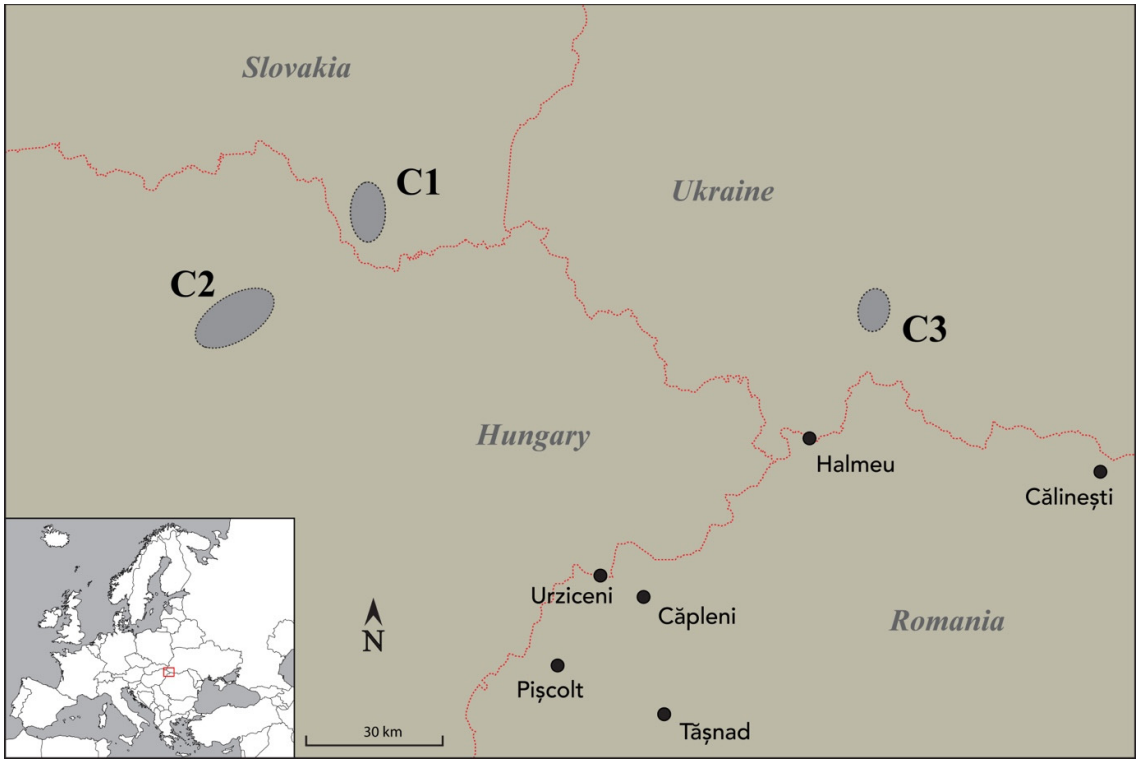

Figure 1. *Locations of archaeological sites and obsidian sources discussed in the text.*

Site	Site type	Period	Culture	No. of samples
Tășnad – *Sere*	settlement	EN	Starčevo-Criș IIIB-IVA	**15**
Călinești-Oaș – *DSM*	settlement	EN	Starčevo-Criș IIIB-IVA	**6**
Halmeu – *Vamă*	settlement	MN	Pișcolt III/Iclod 1	**8**
Halmeu – *Kiraly domb*	settlement	MN	Pișcolt II	**5**
Pișcolt – *Lutărie*	settlement	MN	Pișcolt II	**3**
Urziceni – *Vamă*	cemetery	Copper Age	Bodrogkeresztúr	**30**
Urziceni – *Vamă*	settlement	MN	Pișcolt II	**7**
Căpleni – *Drumul Căminului*	settlement	MN	Pișcolt III	**1**

Table 1. *List of sites, number of measured samples and their cultural attributions. EN – Early Neolithic; MN – Middle Neolithic.*

Tășnad – *Sere* is located to the southwest of the town of Tășnad, on a terrace of the Cehal River. Discovered in the 1970s by Nețа Iercoșan during construction of a canal to divert the waters of the Cehal, excavations started only in 1989, with five further seasons undertaken between 1995 and 1999, all supervised by N. Iercoșan. The rapid development of the nearby spa-town triggered further rescue excavations in 2001–2002 (directed by J. Németi and C. Astaloș) and from 2004 onwards (directed by C. Virag). From 2012 a joint project

between Satu Mare County Museum and University College London started at Tășnad aimed at a detailed investigation of the occupation layer (Astaloș *et alii* 2013; Sommer, Astaloș 2014).

The investigations brought to light archaeological remains attributed to the Early Neolithic (Starčevo-Criș culture), Middle Neolithic (Pişcolt culture), Late Copper Age (Coţofeni culture), Bronze Age and Roman period (Przeworsk culture).

Most of the features belong to the Early Neolithic Criş culture and consist of pits, pit-houses, graves, hearths, ovens and post-built houses. Four single graves were excavated, each containing a 'contracted' inhumation. The Criş artefacts comprise mainly pottery sherds, chipped stone tools, polished axes, querns, anthropomorphic and zoomorphic figurines, clay stamps (*pintaderas*), clay altars, loom-weights and spindle-whorls (Astaloș *et alii* 2013). For the lithic artefacts, both local raw materials, such as jasper and limnic quartzite, and imported siliceous rocks (obsidian, Balkan flint and Prut flint) were used.

Two obsidian artefacts from feature Cx.103 (described as a recessed dwelling of 4 × 1.5 m and dated based on pottery typology to Starčevo-Criș phases IIIB-IVA were analyzed using EDXRF by Glascock *et alii* (2017, p. 177) and provenanced to the Carpathian 1 (C1) source in eastern Slovakia. For our study, 15 obsidian pieces from 10 features (9 'complexes' and one burial [M3]) were analyzed by pXRF, including a blade from burial M3 (Table 2; Fig. 2A).

The analyzed obsidian come from pit houses (Cx.64, Cx.23, Cx.53) and storage pits (Cx.108, Cx.56, Cx.70). Cx.64/2006 is a pit house with a slightly irregular shape (7.5 × 5.5 m), with a maximum depth of 0.80 m; in this feature 10 post holes were identified; the filling of the feature is very dark grey with ubiquitous small daub fragments; in the inventory of the feature was found a fragment of an anthropomorphic pot representing a human leg, as well as numerous clay weights. M3/2006 (= Cx.72/2006) is an intramural inhumation grave with the skeleton in a crouched position on the left side, oriented N–S, with two pieces of obsidian as grave goods.

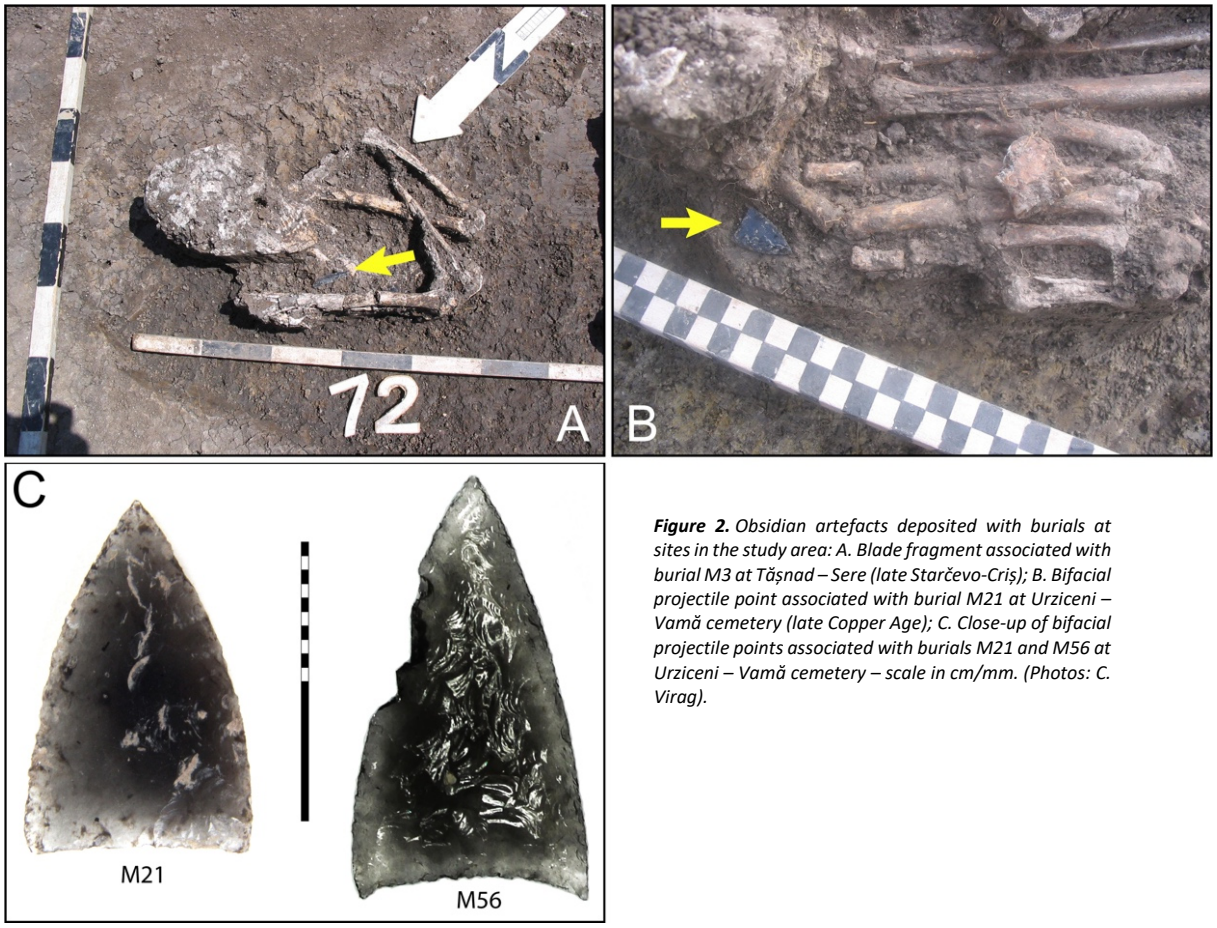

Figure 2. *Obsidian artefacts deposited with burials at sites in the study area: A. Blade fragment associated with burial M3 at Tășnad – Sere (late Starčevo-Criș); B. Bifacial projectile point associated with burial M21 at Urziceni – Vamă cemetery (late Copper Age); C. Close-up of bifacial projectile points associated with burials M21 and M56 at Urziceni – Vamă cemetery – scale in cm/mm. (Photos: C. Virag).*

Sample #	Site	Year excavated	Context	Type	Blank	Dimensions (mm)			W (g)	Cortex	Period	Culture
						L	B	Th				
SM.01	Urziceni – *Vamă*	2014	M48	Blade (distal mesial break)	B	-30.18	8.78	2.27	0.61		Eneolithic	Bodrogkeresztúr
SM.02	Urziceni – *Vamă*	2003	M3	Bifacial projectile point	F?	29.63	19.58	4.18	2.15		Eneolithic	Bodrogkeresztúr
SM.03	Urziceni – *Vamă*	2003	M21	Bifacial projectile point, broken tip	F?	-23.18	19.53	4.21	1.43		Eneolithic	Bodrogkeresztúr
SM.04	Urziceni – *Vamă*	2005	M30	Bifacial projectile point	F?	23.45	15.87	4.58	1.45		Eneolithic	Bodrogkeresztúr
SM.05	Urziceni – *Vamă*	2005	M30	Bifacial projectile point	F?	26.17	16.98	3.55	1.31		Eneolithic	Bodrogkeresztúr
SM.06	Urziceni – *Vamă*	2005	M30	Unretouched flake	F	24.16	23.76	7.73	4.00		Eneolithic	Bodrogkeresztúr
SM.07	Urziceni – *Vamă*	2005	M30	Platform core	P	36.20	24.97	15.33	18.43		Eneolithic	Bodrogkeresztúr
SM.08	Urziceni – *Vamă*	2005	M30	Flake / Split pebble	F/P	-24.13	16.76	8.98	3.79		Eneolithic	Bodrogkeresztúr
SM.09	Urziceni – *Vamă*	2005	M30	Platform core	P	26.00	15.13	12.00	4.58	x	Eneolithic	Bodrogkeresztúr
SM.10	Urziceni – *Vamă*	2005	M30	Platform core	P	32.87	17.62	9.99	7.21		Eneolithic	Bodrogkeresztúr
SM.11	Urziceni – *Vamă*	2005	M30	Unretouched blade	B	34.94	9.80	4.19	1.50		Eneolithic	Bodrogkeresztúr
SM.12	Urziceni – *Vamă*	2005	M30	Bipolar core / Split pebble	P	27.17	14.68	13.19	6.68	x	Eneolithic	Bodrogkeresztúr
SM.13	Urziceni – *Vamă*	2005	M30	Unretouched flake	F	32.70	33.26	10.41	10.32	x	Eneolithic	Bodrogkeresztúr
SM.14	Urziceni – *Vamă*	2005	M30	Unretouched flake	F	48.68	16.37	10.97	8.14	x	Eneolithic	Bodrogkeresztúr
SM.15	Urziceni – *Vamă*	2005	M30	Unretouched flake	F	15.42	14.35	3.00	0.42	x	Eneolithic	Bodrogkeresztúr
SM.16	Urziceni – *Vamă*	2014	M56	Bifacial projectile point	F?	30.91	17.17	3.22	1.30		Eneolithic	Bodrogkeresztúr
SM.17	Urziceni – *Vamă*	2014	M45	Bifacial projectile point	F?	18.60	14.10	3.06	0.58		Eneolithic	Bodrogkeresztúr
SM.18	Urziceni – *Vamă*	2014	M58	Bifacial trapeze?	B/F	13.83	11.60	2.71	0.44	x	Eneolithic	Bodrogkeresztúr
SM.19	Urziceni – *Vamă*	2014	M55	Unretouched blade	B	-57.74	11.27	3.30	1.97		Eneolithic	Bodrogkeresztúr
SM.20	Urziceni – *Vamă*	2014	M50	Blade (distal mesial break)	B	-27.41	8.28	2.41	0.62		Eneolithic	Bodrogkeresztúr
SM.21	Urziceni – *Vamă*	2014	M52	Platform core	P	55.04	23.48	17.80	27.79	x	Eneolithic	Bodrogkeresztúr
SM.22	Urziceni – *Vamă*	2014	M79	Unretouched flake	F	23.19	24.96	5.58	25.60	x	Eneolithic	Bodrogkeresztúr
SM.23	Urziceni – *Vamă*	2014	M45	Platform core	P	31.40	24.53	19.58	11.77		Eneolithic	Bodrogkeresztúr
SM.24	Urziceni – *Vamă*	2014	M71	Bifacial projectile point	F?	24.56	16.98	3.74	1.04		Eneolithic	Bodrogkeresztúr
SM.25	Urziceni – *Vamă*	2014	M71	Bifacial projectile point	F?	18.29	14.75	3.20	0.84		Eneolithic	Bodrogkeresztúr

Sample #	Site	Year excavated	Context	Type	Blank	Dimensions (mm)			W (g)	Cortex	Period	Culture
						L	B	Th				
SM.26	Urziceni – *Vamă*	2014	M70	Edge-retouched blade	B	37.29	15.49	4.11	2.50	x	Eneolithic	Bodrogkeresztúr
SM.27	Urziceni – *Vamă*	2014	M60 vessel 1	Split pebble	P	29.16	30.63	15.70	12.00	x	Eneolithic	Bodrogkeresztúr
SM.28	Urziceni – *Vamă*	2003	M10	Unretouched blade	B	55.09	12.73	3.93	3.15	x	Eneolithic	Bodrogkeresztúr
SM.29	Urziceni – *Vamă*	2014	M62	Edge-retouched blade	B	-42.97	13.42	4.41	3.11	x	Eneolithic	Bodrogkeresztúr
SM.30	Urziceni – *Vamă*	2005	M39	Unretouched blade	B	27.64	11.71	9.59	2.45	x	Eneolithic	Bodrogkeresztúr
SM.31	Urziceni – *Vamă*	2014	M62	Bifacial projectile point	B/F	16.94	14.65	2.40	0.49		Eneolithic	Bodrogkeresztúr
SM.32	Urziceni – *Vamă*	2003	Cx.1	Unretouched flake	F	20.53	-31.04	8.45	5.45	x	Middle Neolithic	Pişcolt II
SM.33	Urziceni – *Vamă*	2003	Cx.1	Bipolar core	P/F	28.63	13.57	4.71	1.96		Middle Neolithic	Pişcolt II
SM.34	Urziceni – *Vamă*	2003	Cx.1	Unretouched flake	F	28.81	37.25	7.65	7.99		Middle Neolithic	Pişcolt II
SM.35	Urziceni – *Vamă*	2003	Cx.1	Edge-retouched blade, mesial fragment	B	-32.49	12.71	5.45	2.69		Middle Neolithic	Pişcolt II
SM.36	Urziceni – *Vamă*	2003	Cx.1	Edge-retouched blade	B	41.40	20.36	5.47	5.21	x	Middle Neolithic	Pişcolt II
SM.37	Urziceni – *Vamă*	2003	Cx.1	Edge-retouched blade	B	67.37	21.59	6.80	10.71		Middle Neolithic	Pişcolt II
SM.38	Călinești Oaș – *DSM*	2000	Cx.1	Platform core	P	22.28	23.52	14.13	8.36	x	Early Neolithic	Criș IIIB-IVA
SM.39	Călinești Oaș – *DSM*	2000	Cx.1	Split pebble	P	38.19	26.06	21.10	12.84	x	Early Neolithic	Criș IIIB-IVA
SM.40	Călinești Oaș – *DSM*	2000	Cx.1	Platform core	P	25.36	18.23	20.20	9.67		Early Neolithic	Criș IIIB-IVA
SM.41	Călinești Oaș – *DSM*	2000	Cx.1	Split pebble	P	31.04	26.34	22.70	15.61	x	Early Neolithic	Criș IIIB-IVA
SM.42	Călinești Oaș – *DSM*	2000	Cx.1	Unworked fragment	-	36.67	34.66	14.51	20.05		Early Neolithic	Criș IIIB-IVA
SM.43	Călinești Oaș – *DSM*	2000	Cx.1	Split pebble	P	32.39	25.65	15.60	11.81	x	Early Neolithic	Criș IIIB-IVA
SM.44	Tășnad – *Sere*	2006	Cx.56	Blade (distal mesial break)	B	-36.30	14.58	5.15	2.71		Early Neolithic	Criș IIIB-IVA
SM.45	Tășnad – *Sere*	2006	Cx.23	Platform core	?	30.13	25.19	21.38	17.02	x	Early Neolithic	Criș IIIB-IVA
SM.46	Tășnad – *Sere*	2006	Cx.44	Unretouched flake	F	38.30	29.13	11.09	8.91	x	Middle Neolithic	Pişcolt I/II
SM.47	Tășnad – *Sere*	2006	Cx.70	Unretouched flake	F	21.40	21.78	9.12	3.06	x	Early Neolithic	Criș IIIB-IVA
SM.48	Tășnad – *Sere*	2006	M3 (Cx.72)	Blade, mesial fragment	B	-53.20	9.62	23.84	11.60	x	Early Neolithic	Criș IIIB-IVA
SM.49	Tășnad – *Sere*	2002	Cx.3	Blade, mesial fragment	B	-32.49	16.08	4.83	2.98		Early Neolithic	Criș IIIB-IVA
SM.50	Tășnad – *Sere*	2006	Cx.53	Platform core	P	21.96	27.05	16.07	7.65		Early Neolithic	Criș IIIB-IVA
SM.51	Tășnad – *Sere*	2006	Cx.53	Blade (distal mesial break)	B	-32.22	16.56	6.56	3.89	x	Early Neolithic	Criș IIIB-IVA

Sample #	Site	Year excavated	Context	Type	Blank	Dimensions (mm)			W (g)	Cortex	Period	Culture
						L	B	Th				
SM.52	Tășnad – *Sere*	2006	Cx.53	Unretouched flake	F	33.06	22.32	4.99	3.59		Early Neolithic	Criș IIIB-IVA
SM.53	Tășnad – *Sere*	2009	Cx.108	Blade, mesial fragment	B	-37.33	27.65	5.92	5.84		Early Neolithic	Criș IIIB-IVA
SM.54	Tășnad – *Sere*	2005	Cx.23	Unretouched flake	F	39.75	48.43	22.47	36.23	x	Early Neolithic	Criș IIIB-IVA
SM.55	Tășnad – *Sere*	2006	Cx.64	Unretouched flake	F	35.94	41.89	9.46	18.10	x	Early Neolithic	Criș IIIB-IVA
SM.56	Tășnad – *Sere*	2006	Cx.64	Unretouched flake	F	69.00	36.49	20.13	40.95	x	Early Neolithic	Criș IIIB-IVA
SM.57	Tășnad – *Sere*	2009	Cx.216	Scraper	?	29.41	25.09	12.73	9.31		Middle Neolithic	Pișcolt II
SM.58	Tășnad – *Sere*	2006	Cx.62	Platform core	P	36.12	45.86	23.35	41.01		Early Neolithic	Criș IIIB-IVA
SM.59	Halmeu – *Vamă*	2008	Cx.40	Edge-retouched flake	F	28.66	15.14	5.51	2.41	x	Middle Neolithic	Pișcolt III
SM.60	Halmeu – *Vamă*	2008	Cx.20	Platform core	P	29.97	27.14	27.03	29.92	x	Middle Neolithic	Pișcolt III
SM.61	Halmeu – *Vamă*	2008	Cx.10	Platform core	P	33.53	25.67	31.56	35.33	x	Middle Neolithic	Pișcolt III
SM.62	Halmeu – *Vamă*	2008	Cx.10	Unretouched blade	B	-66.64	18.68	5.26	6.93		Middle Neolithic	Pișcolt III
SM.63	Halmeu – *Vamă*	2008	Cx.46	Bipolar core	F	34.32	25.53	8.00	8.39		Middle Neolithic	Pișcolt III
SM.64	Halmeu – *Vamă*	2008	Cx.33	Bipolar core	P	22.01	16.03	10.59	4.33		Middle Neolithic	Pișcolt III
SM.65	Halmeu – *Vamă*	2008	M1 (Cx.22)	Blade, mesial fragment	B	-20.01	13.88	2.15	0.80		Middle Neolithic	Pișcolt III
SM.66	Halmeu – *Vamă*	2003	Cx.4	Unretouched flake	F	-24.66	17.34	5.51	2.35		Middle Neolithic	Pișcolt III
SM.67	Halmeu – *Király domb*	2002	Cx.12	Platform core	P	29.91	31.31	32.81	39.70	x	Middle Neolithic	Pișcolt II
SM.68	Halmeu – *Király domb*	2002	Cx.11	Unretouched blade / flake	B/F	-31.60	27.24	7.81	4.92		Middle Neolithic	Pișcolt II
SM.69	Halmeu – *Király domb*	2002	Cx.12B	Edge-retouched blade / Scraper	B	43.53	20.48	5.95	5.41		Middle Neolithic	Pișcolt II
SM.70	Halmeu – *Király domb*	2002	Cx.8 (area of)	Platform core	P	32.53	14.75	15.44	9.42		Middle Neolithic	Pișcolt II
SM.71	Halmeu – *Király domb*	2002	Cx.12B	Platform core	P	32.54	21.56	13.64	13.64		Middle Neolithic	Pișcolt II
SM.72	Pișcolt – *Lutărie*	1999	G11	Bipolar core	P/F	42.29	43.35	27.14	54.24	x	Middle Neolithic	Pișcolt II
SM.73	Pișcolt – *Lutărie*	1970	G1	Unretouched flake	F	-26.88	21.66	5.18	2.94		Middle Neolithic	Pișcolt II
SM.74	Pișcolt – *Lutărie*	1976	G4	Unretouched flake	F	19.07	28.04	7.92	3.91	x	Middle Neolithic	Pișcolt II
SM.75	Căpleni – *Drumul Căminului*	2001	G1	Blade, mesial fragment	B	-42.93	20.70	5.03	3.40		Middle Neolithic	Pișcolt III

Table 2. *Details of obsidian artefacts analyzed by pXRF. Key: B – blade, F – flake, P – pebble/nodule; a minus sign before a measurement indicates that the dimension is affected by a break.*

Halmeu – *Vamă* is located on the west bank of the Egherul Mare creek (a tributary of the Tur River), on a low terrace subject to periodic flooding. The entire area of the site is covered by a 20 cm thick alluvial deposit that overlies the occupation levels. The site was discovered in 2000 and excavated between 2000 and 2014, under the direction of L. Marta and C. Virag. The archaeological remains were attributed to Middle Neolithic (Pișcolt group) and Bronze Age occupations. The Middle Neolithic settlement was protected by ditches and three rows of palisades. The architectural features comprised surface and sunken dwellings as well as a large number of pits with various functions (clay extraction, storage and refuse pits – Virag 2015). The three artefacts analyzed by Glascock *et alii* 2017 came from feature Cx.4/2003 (7.40 x 4.60 m) – which those authors assigned to the Pișcolt IIIB stage (based on pottery typology) – and were provenanced to the Cejkov-Viničky (C1) source area in eastern Slovakia. The eight samples from Halmeu – *Vamă* analyzed for our study came from six different features – comprising ditches (Cx.4, Cx.20, Cx.40), pits (Cx.33, Cx.46) and a probable human burial (M1/Cx.22) (Table 2) – which were also assigned to the Middle Neolithic (stage Pișcolt III) based on pottery typology. The burial (M1) consisted of a rectangular pit measuring 2.37 × 0.96 m and oriented SSE–NNW, from which were recovered a few poorly preserved and unidentifiable fragments of bones and teeth. The 'grave inventory' comprised two boar tusks (interpreted as 'pendants'), six polished stone artefacts and 12 chipped stone artefacts (including a core, an endscraper and retouched and unretouched blades and bladelets).

Halmeu – *Király Domb* was discovered in 2000 close to the Halmeu – *Vamă* site, on a terrace of the Egherul Mare creek. Test pits in 2000 and 2004 suggested that the Neolithic occupation observed at Halmeu – *Vamă* also extended into this area. Two mounds (*Király Domb I* and *II*) surrounded by drainage ditches were investigated. Three stratigraphic horizons were identified: 1. Ploughsoil, 40 cm thick, containing mixed Neolithic, Bronze Age and medieval finds; 2. Below this a layer, 20–30 cm thick, containing the remains of the Neolithic occupation (pits and agglomerations of sherds), cut by later features; 3. Yellow clay, archaeologically sterile. The archaeological materials from the Middle Neolithic occupation comprised pottery sherds and lithics, but very few faunal remains or artefacts made of bone. A study of 391 lithic items (Chmielewski 2012) showed the raw materials to be mainly limnic silicolite, silicified gritstone, vitreous dacite, Dniestr flint and obsidian. Typologically, the assemblage comprised flake and blade blanks, various tools, cores and débitage. We undertook pXRF analyses of six obsidian artefacts excavated from five pit features (Table 2).

Pișcolt – *Lutărie* is located ca. 200 m south of the outskirts of Pișcolt village. The site occupied a former clay quarry in the bed of Ierul Rece brook. The site was discovered in 1970 following the digging of clay extraction pits by local people. Archaeological excavations directed by J. Németi took place between 1986 and 1989 and continued (with gaps) until 2001 mainly under the direction of J. Németi and R. Gindele (Hágó, Németi 2013; Lazarovici, Németi 1983). The archaeological remains were attributed to the Middle Neolithic (Pișcolt culture – two phases of occupation), La Tène and Migration periods (Celts and Sarmatians). The Middle Neolithic occupation yielded a large pottery assemblage (some decorated with incisions or painted with black) together with polished stone tools, chipped lithics and faunal remains. The three obsidian pieces (two cores and one flake) measured by pXRF in our study came from pit features G1, G4 and G11.

The site at **Urziceni – *Vamă*** was discovered in 2003 during survey work prior to construction of the customs post at the Romanian-Hungarian border crossing point. The archaeological site lies on the (once swampy) valley of the Negru River. Started in 2003 the on-going excavations (led by C. Virag) uncovered the remains of a Copper Age (Bodrogkeresztúr culture) cemetery, partially overlapping a Middle Neolithic (Pișcolt culture) settlement. Remains attributed to the Late Bronze Age (Gàva culture) and Roman period were also recorded. The Copper Age cemetery was ^{14}C dated to 4300–4000 cal BC (Virag unpublished). 103 burials were discovered between 2003 and 2017. Some tombs had spectacular grave goods: pottery vessels, copper adornments and weapons, gold items, *Spondylus* shell ornaments, stone projectile points and blades. Individuals were positioned lying on one side (women on the left, men on the right), oriented E–W, at ca. 50 cm depth. Grave goods differed between burials of men and women. A total of 37 obsidian artefacts from the Urziceni – *Vamă* site were analyzed by pXRF for this study. Most (31) came from Copper Age burials (Fig. 2B), one burial (M30) producing 12 pieces (Fig. 2C); the other six pieces came from a Middle Neolithic pit feature designated Cx.1 (Table 2).

Căpleni – *Drumul Căminului*. The Neolithic settlement is often cited in the archaeological literature as the *Reformed Cemetery* (Németi 1999, p. 77), and was previously referred to as *Grădinărie* I (Németi 1986–1987, p. 26, fig. 12–13, 26–27, point B). The single piece of

obsidian analyzed from this site came from feature G1/2001, which was discovered during the installation of the Romtelecom fibre-optic cable (Németi 2017, p. 105–106). The most distinctive find from the pit-feature is a ceramic fragment with the schematic representation of a human figure in a praying position. Based on pottery typology feature G1/2001 has been attributed to phase III of the Pişcolt culture.

MATERIALS AND METHODS

Details of the obsidian samples analyzed for this study are presented in Table 2. Non-destructive pXRF measurements were made on 75 artefacts from seven sites in the Satu Mare County of northwest Romania. The work was undertaken at the Satu Mare County Museum over a 2-day period in August 2016. The analyses were performed using a Niton 'XL3t ultra' portable XRF analyzer. Following our standard methodology, two sets of measurements were taken on each piece using the factory-set 'Mining' (Fundamental Parameter) and 'Soils' (Compton Normalization) calibrations, respectively. For both sets of analyses, 'spot size' (the diameter of the analysis area) was set to 8 mm, and the measurement time per sample to 180 seconds.

For present purposes, we use the assay data generated by the 'Mining' (FP) calibration, which has been found to provide reliable results for a range of major, minor and trace elements (including Ti, Fe, Zn, Rb, Sr, Y, Zr, Nb, Pb, Th and U) that are particularly useful in obsidian provenancing research. Matching of the archaeological samples to their original source(s) can be achieved by comparing these results against equivalent data for known obsidian sources; previously, using the same pXRF analyzer with the same settings, we established a library of analytical data for samples collected from geological sources in the Carpathians, the Aegean, Central Anatolia and the Central Mediterranean.

RESULTS AND DISCUSSION

Energy Dispersive X-ray Fluorescence (EDXRF) is an effective and non-destructive technique for elemental analysis of materials and has been used extensively in obsidian provenancing research. While the detection systems in laboratory-based instruments have a wider analytical range and can be used on a greater variety of sample types, handheld XRF analyzers like the 'Niton XL3t' have a number of advantages for archaeological research. They permit rapid identification and quantification of elements at the ppm level. Moreover, they can be used 'on location' – that is, in the field or wherever the archaeological finds are kept. In practical terms, pXRF enables larger numbers of samples to be analyzed more quickly and at lower cost.

The nearest geological sources of obsidian to the Satu Mare region archaeological sites discussed in this paper are those on the western flank of the Carpathian Mountains (Fig. 1). Three main source areas have been identified within the Carpathians (Biró 2006; 2014; Rosania *et alii* 2008): Carpathian 1 (C1) in the Zemplín Hills of eastern Slovakia; Carpathian 2 (C2) in the Tokaj Mountains of northeast Hungary; and Carpathian 3 (C3) in the Transcarpathian region of southwest Ukraine. In both the Slovakian and Hungarian source areas two obsidian variants have been recognized: C1a/C1b in Slovakia and C2E/C2T in Hungary.

Table 3 shows the approximate straight-line distances between the Satu Mare region archaeological sites and each of Carpathian obsidian source areas. By far the nearest obsidian source to at least six of the sites is the Carpathian 3 source between Malyj Rakovets and Rokosovo in southwestern Ukraine. However, previous research suggests that archaeological occurrences of C3 obsidian have a predominantly local distribution around the source. So far, the only recorded occurrences of C3 obsidian outside Ukraine are at Late Pleistocene sites in the northwest Romania (Dobrescu *et alii* 2018).

		C1	C2	C3
1.-2.	**Halmeu – *Vamă* and Halmeu – *Király Domb***	105	120	35
3.	**Călinești-Oaș – *DSM***	165	185	60
4.	**Căpleni – *Drumul Căminului***	100	105	80
5.	**Urziceni – *Vamă***	95	95	80
6.	**Tășnad – *Sere***	125	125	100
7.	**Pișcolt – *Lutărie***	105	100	105

Table 3. *Approximate straight-line distances (in kilometres) between archaeological sites and obsidian source areas.*

Obsidian generally is a scarce raw material in Romanian prehistoric sites. Unsurprisingly, some of the highest frequencies have been recorded in northwest Romania. A study of Early Upper Palaeolithic sites in the region found that the proportion of obsidian among the primary materials ranged between 0.64% and 23% (Dobrescu *et alii* 2018). Among the much later sites discussed here obsidian frequencies have been observed to be similarly variable, from 4.5% at Călinești-Oaș – *DSM* (Chmielewski, Astaloș 2015) to 90% at Tășnad – *Sere* (Chmielewski 2012). These variations suggest that distance to source was not the only, or necessarily the primary, determinant of obsidian use.

Each of the Carpathian obsidian sources has a relatively distinct chemical signature. It is possible to distinguish between the C1, C2 and C3 sources (and, to some extent, their variants) using the elemental concentrations of zirconium (Zr), strontium (Sr) and rubidium (Rb). These same elements are also useful for discriminating between the Carpathian and other European (and Central Anatolian) sources (Fig. 3).

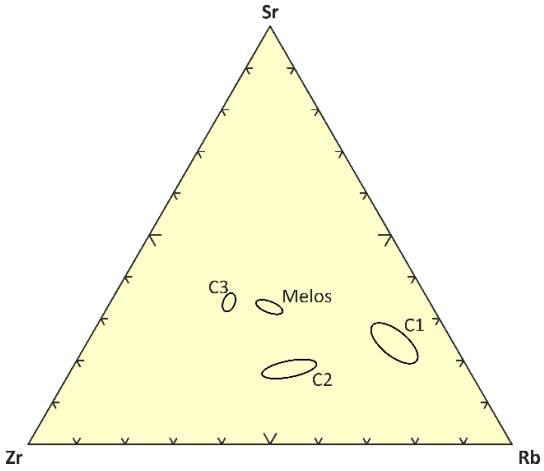

Figure 3. *Ternary graph of the range of variation in Zr/Sr/Rb compositions (normalized) of geological reference samples from obsidian sources in the Carpathians (C1, C2, C3) and on the island of Melos.*

Figure 4 plots the normalized Zr/Sr/Rb data for the archaeological samples (by site and period) against the compositional ranges obtained for geological samples from Carpathian 1, 2 and 3 source areas, using the factory-set 'Mining' calibration of the XL3t analyzer. In all cases, the archaeological samples have trace element compositions that correspond closely with that of Carpathian 1 obsidian. These results reinforce the pattern we and others have found at sites elsewhere in Romania and in northern Bulgaria (Dobrescu *et alii* 2016; Bonsall *et alii* 2017a; 2017b; Boroneanț *et alii* 2018; Glascock *et alii* 2017; Boroneanț & Bonsall, unpublished) which indicates a clear preference for Carpathian 1 obsidian throughout the time range from the later stages of the Early Neolithic to the Bronze Age.

Over the time range represented by the sites included in this study (late Early Neolithic to late Copper Age, ca. 5700–4000 cal BC) obsidian artefacts have been found in both domestic and funerary contexts. Parts of obsidian blades occurred in a late Criș burial at Tășnad – *Sere* and a Pișcolt III burial at Halmeu – *Vamă*. Across Southeastern Europe the Copper Age saw a marked increase in the quantity and variety of grave goods in burial sites and the appearance of 'rich' graves furnished with precious and/or exotic items, including gold objects. They include the famous Varna I necropolis on the Black Sea coast of Bulgaria dated to ca. 4550–4400 cal BC (Higham *et alii* 2018) and the necropolis at Urziceni – *Vamă* dating to ca. 4300–4000 cal BC (Virag 2004, Mathieson *et alii* 2018, Virag unpublished). Among the grave inventories of both sites were exceptionally fine examples of artefacts made of Carpathian 1 obsidian (Bonsall *et alii* 2017b; Virag unpublished). Of particular note among the obsidian finds from the Urziceni – *Vamă* necropolis are a series of distinctive bifacial projectile points made of C1 obsidian (Fig. 2), with close parallels in sites of the Cucuteni-Trypillia culture to the east of the Carpathian Mountains (Anthony 2007).

CONCLUSIONS

The research presented in this paper represents the most detailed study to date of obsidian use during the Neolithic and Copper Age periods in northwest Romania. All of the obsidian samples analyzed originated in the Carpathian 1 source area. Distance to source appears not to have been a critical factor in the occurrence of obsidian artefacts at the archaeological sites investigated. Obsidian from the nearest source (Carpathian 3) has not so far been found on any Neolithic or later site. The sites are more or less equidistant from the Carpathian 1 and 2 source areas, yet C1 obsidian was preferred. The long-term chronological pattern that emerges from this and previous studies (*e.g.* Dobrescu *et alii* 2016; Glascock *et alii* 2017) is that obsidian use in northwest Romania occurred over a period from at least the beginning of the Upper Palaeolithic to the Bronze Age. There was much greater variety of source use in the Late Pleistocene (when obsidian was acquired from all three Carpathian source areas) compared to the Holocene. From the later stages of the Early Neolithic onward Carpathian 1 obsidian seems to have been used preferentially and, perhaps, exclusively.

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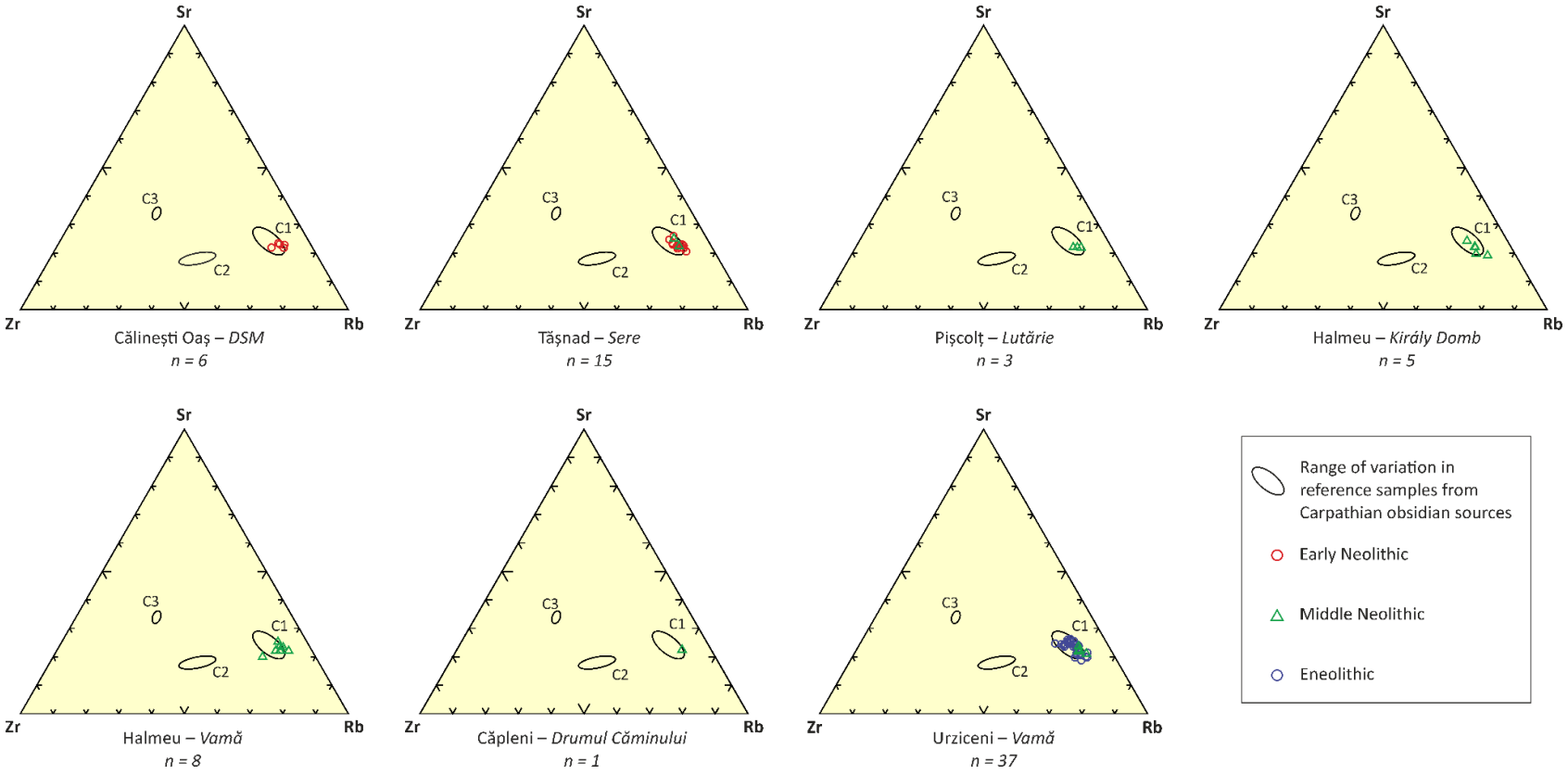

Figure 4. *Ternary diagram of Zr/Sr/Rb data for obsidian artefacts from Neolithic and Copper Age sites in Satu Mare County plotted against the compositional ranges of obsidian reference samples from sources in the Carpathians (ellipses). All measurements taken with a Niton 'XL3t ultra' handheld pXRF analyzer using the factory-set Fundamental Parameter 'Mining' calibration (not calibrated using standard reference materials).*

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ABRÉVIATIONS / ABBREVIATIONS / ABREVIERI

AA – Archäologischer Anzeiger. Deutsches Archäologisches Institut, Darmstadt, München, Tübingen–Berlin
ACMI – Anuarul Comisiunii Monumentelor Istorice, Bucureşti
ActaMN – Acta Musei Napocensis, Cluj
ActaMP – Acta Musei Porolissensis, Zalău
ActaTS – Acta Terrae Septemcastrensis, Universitatea Lucian Blaga, Sibiu
Acta Siculica – Acta Siculica. Anuarul Muzeului Naţional Secuiesc, Sfântu Gheorghe
l'Anthropologie (Paris) – l'Anthropologie, Paris
Antiquity – Antiquity. A Quarterly Review of Archaeology, University of York
Anuarul MJIAP – Anuarul Muzeului Județean de Istorie și Arheologie Prahova, Ploiești
ARA – Annuaire Roumain d'Anthropologie
Archaeometry – Archaeometry, Research Laboratory for Archaeology and the History of Art, Oxford University
ArchBulg – Archaeologia Bulgarica, Sofia
Area – Area, Royal Geographical Society, London
ArheologijaKiiv – Arheologija. Nacional'na akademija nauk Ukraini. Institut archeologii, Kiiv
ArheologijaSSSR – Arheologija SSSR. Svod Archeologičeskih Istočnikov, Moskva
ArhMold – Arheologia Moldovei, Iaşi
BA – Biblioteca de Arheologie, Bucureşti
BARIntSer – British Archaeological Reports. International Series, Oxford
BiblThrac – Bibliotheca Thracologica, Bucureşti
BMC – *Coins of the Roman Empire in the British Museum*, London. I, *Augustus to Vitellius*, 1923; II, *Vespasian to Domitian*, 1930; III, *Nerva to Hadrian*, 1936; IV, *Antoninus Pius to Commodus*, 1968; V, *Pertinax to Elagabalus*, 1950 (H. Mattingly); VI, *Severus Alexander to Balbinus and Pupienus*, 1962 (R.A.G. Carson)
BMJT – Buletinul Muzeului Judeţean Teleorman, Alexandria
BMJTAG – Buletinul Muzeului Județean „Teohari Antonescu", Giurgiu
BSNR – Buletinul Societăţii Numismatice Române, Bucureşti
Bull. et Mém. de la Soc. d'Anthrop. de Paris – Bulletins et Mémoires de la Société d'Anthropologie de Paris
CA – Cercetări Arheologice, Bucureşti
Caiete ARA - Caietele ARA, Revistă de Arhitectură, Restaurare şi Arheologie, Asociaţia ARA, Bucureşti
CCA – Cronica Cercetărilor Arheologice din România, Bucureşti
CercNum – Cercetări Numismatice, București
Dacia / Dacia NS – Dacia / Dacia Nouvelle Série. Revue d'archéologie et d'histoire ancienne. Académie Roumaine. Institut d'archéologie « Vasile Pârvan », Bucarest
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EAIVR – C. Preda (ed.), *Enciclopedia Arheologiei și Istoriei Vechi a României*, vol. I-III (1994, 1996, 2000), București
EphemNap - Ephemeris Napocensis. Academia Română, Institutul de Arheologie şi Istoria Artei, Cluj-Napoca
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Göbl – R. Göbl, *Die Münzprägung der Kaiser Valerianus I. / Gallienus / Saloninus (253/268), Regalianus (260) und Macrianus / Quietus (260–262)*, Viena, 2000
IJO – International Journal of Osteoarchaeology
IstMitt – Istanbuler Mitteilungen, Istanbul
Istros – Istros, Muzeul Brăilei, Brăila
JAS – Journal of Archaeological Science, London
JEA – Journal of European Archaeology
JFA – Journal of Field Archaeology

KSIA (Kiiv) – Kratkije Soobščenija Instituta Arheologij Akademij Nauk SSSR, Kiiv
KSIA (Moskva) – Kratkije Soobščenija Instituta Arheologij Akademij Nauk SSSR, Moskva
Ktèma – Civilisations de l'Orient, de la Grèce et de Rome antiques, Strasbourg
MCA – Materiale şi Cercetări Arheologice, Bucureşti
MemAnt – Memoria Antiquitatis, Piatra Neamţ
MIAR – Materialy i issledovanija po arheologii Rossii
MIBE – W. Hahn, M.A. Metlich, *Money of the Incipient Byzantine Empire (Anastasius I – Iustinian I, 491–565)*, Viena, 2000
Mousaios – Mousaios. Buletinul Ştiinţific al Muzeului Judeţean Buzău
MuzNaţ – Muzeul Naţional, Bucureşti
NZ – Numismatische Zeitschrift, Viena
Peuce – Peuce, Studii şi cercetări de istorie şi arheologie, Institutul de Cercetări Eco-Muzeale, Tulcea
Pick, Regling – B. Pick, K. Regling, *Die antiken Münzen Nord-Griechenlands*, I, *Die antiken Münzen von Dacien und Moesien*, Berlin, 1, 1898 (B. Pick), 2, 1910 (B. Pick, K. Regling)
Pink, NZ – K. Pink, *Der Aufbau der Römischen Münzprägung in der Kaiserzeit*. VI/1, *Probus*, NZ, 71, 1946, p. 13-74
Pontica – Pontica. Studii şi materiale de istorie, arheologie şi muzeografie, Muzeul de Istorie Naţională şi Arheologie Constanţa
PZ – Prähistorische Zeitschrift, Berlin-Mainz
RA – Revue Archéologique, Paris
Radiocarbon – An International Journal of Cosmogenic Isotope Research, Cambridge
REA – Revue des Études Anciennes, Bordeaux
RevBistr – Revista Bistriței. Complexul Muzeal Bistriţa-Năsăud, Bistriţa
RevMuz – Revista Muzeelor, Bucureşti
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RIC IV, 1 – H. Mattingly, E.A. Sydenham, *The Roman Imperial Coinage*, IV, 1, *Pertinax to Geta*, London, 1968
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RIC VI – C.H.V. Sutherland, *The Roman Imperial Coinage*, VI, *From Diocletian's reform (A.D. 294) to the death of Maximinus (A.D. 313)*, London, 1967
RIC VII – P.M. Bruun, *The Roman Imperial Coinage*, VII, *Constantine and Licinius A.D. 313-337)*, London, 1966
RIC IX – J.W.E. Pearce, *The Roman Imperial Coinage*, IX, *Valentinian I-Theodosius I*, London, 1933 (retipărit 1968)
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Quaternary International – Quaternary International. The Journal of the International Union for Quaternary Research
SAA – Studia Antiqua et Archaeologica, Iaşi
SCA – Studii și Cercetări de Antropologie, București
SCIV(A) – Studii şi Cercetări de Istorie Veche (şi Arheologie), Bucureşti
SCN – Studii şi Cercetări de Numismatică, Bucureşti
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SovArh – Sovetskaja Arheologija, Moskva
SP – Studii de Preistorie, Bucureşti
Stratum(Plus) – Stratum (Plus), Şcoala Superioară de Antropologie, Chişinău, Sankt Petersburg, Bucureşti
StudCom Satu Mare – Studii şi comunicări Satu Mare
StudCom Sibiu – Studii şi Comunicări, Sibiu
Th-D – Thraco-Dacica, București
Tyragetia – Tyragetia. Anuarul Muzeului Naţional de Istorie a Moldovei, Chişinău
Vărbanov – I. Vărbanov, *Greek Imperial Coins and their Values (The Local Coinage of the Roman Empire)*, I, *Dacia, Moesia Superior, Moesia Inferior*, Burgas, 2005
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